REMARKS

In the final Office Action, the Examiner rejected claims 1-7, 10-14, 16, and 17 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,599,842 of Chao et al. in view of U.S. Patent No. 6,224,677 of Nozawa et al.; and rejected claim 15 under 35 U.S.C. § 103(a) as being unpatentable over Chao et al. and Nozawa et al. in view of U.S. Patent No. 5,565,114 of Saito et al. The Examiner also objected to claims 8 and 9 as being dependent upon a rejected base claim, but allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Applicants thank the Examiner for the indication of allowable subject matter in claims 8 and 9.

Applicants respectfully traverse the Examiner's rejection of claims 1-7, 10-14, 16, and 17 under § 103(a) as being unpatentable over Chao et al. in view of Nozawa et al. With respect to Chao et al., the Examiner is correct that Chao et al. fails to disclose a step of introducing again at least part of the processed gas exhausted from the chamber into the chamber again. However, Applicants respectfully disagree with the Examiner's assertion that Nozawa et al. "teaches to re-circulate part of the process gas exhausted from the process chamber into the process chamber." (Office Action at page 3)

Nozawa et al. teaches a conventional technique disclosed by Applicants at page 7, lines 17 et seq. of their application. As Applicants explained, the technique "of mounting a gas refining mechanism to the circulating pipe such that exhaust gas is refined and, then, returned to the process chamber," has a drawback of requiring "costly facilities in addition to the gas recirculation mechanism." (application at page 8, lines 16-18).

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At the very least, the Examiner has failed to establish a *prima facie* case for obviousness because there is no motivation to combine Chao et al. and Nozawa et al. The Examiner explains that it would have been obvious to one having ordinary skill in the art at the time of the invention to "modify Chao in view of Nozawa. . . because it will reduce the . . . operation cost." However, as explained by Applicants, this conventional technique has the drawback of requiring costly facilities to recover and purify the processed gas prior to recirculating it to the process. Thus, one of ordinary skill would not have been motivated to modify Chao et al. to incorporate the teaching of Nozawa et al. because that teaching does not consist of recirculating the processed gas. Instead, that teaching requires first recovering and purifying the processed gas and then providing the purified gas for use in the process. Since one of ordinary skill would not have combined Chao et al. and Nozawa et al., the Examiner has failed to establish a *prima facie* case of obviousness. Applicants therefore respectfully submit that claims 1-7, 10-14, 16, and 17 are patentable.

Further, assuming, *arguendo*, that Chao et al. and Nozawa et al. could be combined, the resulting combination would still not teach or suggest the combination recited in Applicants' claim 1. As shown in the graph of Applicants' FIG. 3, when etching is performed with a circulating ratio set at 0%, the exhaust gas components are different from the components of the newly introduced gas (C_4F_8).

According to Applicants' invention as recited in claim 1, process gas is newly introduced into a process chamber and exhausted from the process chamber as exhaust gas. This exhaust gas is reintroduced (as it is) as recovered exhaust gas. As a

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result, gas which is introduced again into the chamber as recovered gas is made of components different from the components of the newly introduced gas.

When plasma processing is performed by introducing a different-component gas into the chamber, the characteristics of the process are determined by an introducing condition. In order to acquire the same characteristics during the plasma processing, recovered gas must be introduced into a chamber according to a condition which is different from that of the newly introduced gas. This introducing condition can include gas flow rate and flow rate ratio. In other words, in order for recovered gas to be in an introducing condition which is different from the newly introduced gas, introduction of recovered cleaning gas must be controlled by valves, etc. in a different manner from the initial introducing condition.

One embodiment of Applicants' invention is directed to obtaining a predetermined property value to monitor plasma processing and controlling the introducing condition according to the monitored property value. Thus, Applicants' claim 1 is directed to a combination of features including "obtaining a predetermined property value to monitor the state of said plasma of said process gas within said process chamber; and controlling an introducing condition of said process gas into said process chamber so as to adjust said predetermined property value to a regulated value."

Chao et al. discloses a "process monitor 108 can be any sensor, or combination of sensors, for measuring a condition that is dependent on the process occurring within chamber" (column 4, lines 20-22). According to Chao et al., a monitor is used during processing, in order to determine the etching state. For example, Chao et al. states:

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(a) "The OES [Optical Emission Spectrometer] monitors emission of radiation from plasma 130. Such radiation is dependent on the progress of the process occurring in process chamber 101." (column 4, lines 24-26).

(b) "Alternatively, process monitor 108 could include an interferometer for measuring elevations such as the depth of trenches etched into a surface of the wafer 110. Such an interferometer measures the depth of the trenches by interference of light reflected from the top and bottom of the trenches." (column 4, lines 27-32).

Both of these monitoring techniques disclosed by Chao et al. merely indicate the progress of etching.

Chao et al. describes etching methods for top-corner-rounding (TCR) of trenches, bottom-corner-rounding (BCR) of trenches, and removing damaged outer surfaces of a trench as follows:

(a) "The duration of TCR process may be set by performing the process for a predetermined time, or using an end-point detection system or other form of in-situ monitoring system." (Column 7, lines 62-64)

(b) "The ideal duration of BCR process may be set by performing the process for a predetermined time, or using an end-point detection system or other form of in-situ monitoring system." (Column 8, lines 35-41)

(c) "The duration of soft etch process may be set by performing the process for a predetermined time, or using an end-point detection system or other form of in-situ monitoring system." (Column 9, lines 18-21)

Thus, the methods disclosed by Chao et al. comprise monitoring to keep track of the progress of etching and to determine the processing time. Chao et al. does not

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control an introducing condition of process gas so as to adjust a predetermined property value to a regulated value. In other words, Chao et al. does not determine a gas flow rate. According to Chao et al., the appropriate type and flow rate of gas are determined by the resultant shape of the etching process, and are determined experimentally for each application. This is evident from the following descriptions in Chao et al.:

(a) "The presence of SF_6 in the process gas enhances rounding of the bottom corners." (Column 8, lines 31-33)

(b) "Generally, increasing the source power, increasing the chamber pressure, increasing the flow rate of SF6 or CF_4, all increase the amount of rounding occurring at the bottom corners." (Column 8, lines 42-44)

It is clear that Chao et al. does not suggest anything about determining a gas flow rate so that a predetermined property value obtained from the monitor disclosed therein is adjusted to a regulated value. Further, as pointed out by the Examiner, Chao et al. fails to disclose a step of introducing again at least part of the process gas exhausted from the chamber into the chamber again.

With respect to Nozawa et al., the Examiner points out in the last three lines on page 4 of the Detailed Action, that "Nozawa discloses the process gas exhausted from the chamber is re-circulated easily **without changing the component of the process gas**." The Examiner further states in the last three lines on page 5 of the Detailed Action, "Nozawa clearly teaches the **introducing of recovered cleaning gas was control** by plurality of valves and gas mixing regulation device (Fig 1)."

Nozawa et al., discloses introducing exhaust gas from the chamber into the chamber again as recovered gas after it is filtered, liquefied and purified. In particular,

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Nozawa et al. discloses a purification device E (shown in Fig. 1) "constructed such that a rectification unit (not shown) is provided for rectifying a liquid recovered by way of the recovery pipe 4, whereby **pure cleaning gas**, e.g., nitrogen trifluoride (NF_3), can be obtained by rectification. The nitrogen triflouride (NF_3) obtained will be used as the cleaning gas to be supplied to the CVD device A." (emphasis added) Therefore, according to the teaching of Nozawa et al., the components of recovered gas are equal to the components of introduced gas.

Since Nozawa et al. teaches that the components of recovered gas and introduced gas are the same, they can be introduced into the chamber according to the same introducing **condition**. In other words, introducing recovered cleaning gas is controlled by valves, etc. **in the same manner** as the initial introducing condition. As a result, according to Nozawa et al., it is not required to find a different introducing condition of process gas. In contrast, Applicants' invention is directed to finding a different introducing condition of process gas. In particular, Applicants' claimed invention as recited in claim 1 requires a combination of features including "introducing again at least a part of said process gas exhausted from said process chamber into said process chamber;" and "controlling an introducing condition of said process gas into said process chamber so as to adjust said predetermined property to a regulated value."

Applicants therefore respectfully submit that claim 1 and claims 2-7 and 10 that depend therefrom are allowable, in addition to claims 8 and 9, which the Examiner has indicated recite allowable subject matter.

Independent claim 11 recites features corresponding to those of claim 1 and is therefore also patentable for the reasons set forth above. Claims 12-14, 16, and 17 are

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also patentable over Chao et al. and Nozawa et al. at least due to their dependence from allowable claim 11.

Applicants respectfully traverse the Examiner's rejection of claim 15 as unpatentable over Chao et al., Nozawa et al. and Saito et al.. Saito et al. appears to be directed to a method and device for detecting an end point of a plasma process (title). Saito fails to cure the deficiencies of Chao et al. and Nozawa et al. at least because it does not disclose or suggest introducing again any process gas exhausted from a process. Applicants therefore respectfully submit that claim 15 is allowable not only due to its dependence from allowable claim 11 but also because Saito et al. does not overcome the above-noted deficiencies of Chao et al. and Nozawa et al..

Applicants respectfully request that the Examiner consider Applicants' remarks, withdraw the outstanding rejections, and allow this application.

Please grant any extensions of time required to enter this Amendment After Final and charge any additional required fees to our deposit account 06-0916.

Respectfully submitted,

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